

**CLAIMS**

1. A monolithically integrated optical device comprising:  
a first optical cavity having a first optical axis and supporting first  
5 optical modes;  
a second optical cavity having a second optical axis and second,  
different, optical modes than the first optical cavity;  
the first and second optical cavities being laterally offset from one  
another and at least partially separated by a photonic crystal material in  
10 which the dielectric function of the material exhibits a periodic variation as a  
function of linear distance through the material, such that optical coupling  
between the first and second cavities is achieved through the photonic  
crystal.
- 15 2. The optical device of claim 1 in which the first and second optical  
axes are parallel.
3. The optical device of claim 1 in which the first and second optical  
axes are non-parallel.
- 20 4. The optical device of claim 1 in which the first and second optical  
cavities are of different lengths.
5. The optical device of claim 4 in which one of the cavity end mirrors  
25 of the first optical cavity is co-planar with a corresponding one of the cavity  
end mirrors of the second optical cavity.
6. The optical device of claim 5 in which the photonic crystal material  
forms the corresponding cavity end mirrors of the first and second optical  
30 cavities.

7. The optical device of claim 4 in which neither of the cavity end mirrors of the first optical cavity is co-planar with either cavity end mirror of the second optical cavity.

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8. The optical device of claim 1 in which the first and second optical cavities are separated by the photonic crystal material along lateral edges thereof.

10 9. The optical device of claim 1 further including at least a third optical cavity having a third optical axis and supporting third optical modes,  
the third optical cavity being separated from at least one of the first or second optical cavities by the same or further photonic crystal material such that optical coupling between the cavities is achieved through the same or  
15 further photonic crystal material.

10. The optical device of claim 1 in which the photonic crystal material exhibits a periodicity along an axis orthogonal to the first and/or the second optical axis.

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11. The optical device of claim 1 in which the photonic crystal material exhibits a periodicity along an axis parallel to the first and/or second optical axis.

25 12. The optical device of claim 1 in which the photonic crystal material exhibits periodicity along two or more axes.

13. The optical device of any preceding claim in which the photonic crystal material is formed in a quantum well intermixed region of a substrate  
30 of the optical device.

14. A monolithically integrated optical device comprising:  
a first optical cavity having a first optical axis and supporting first optical modes;  
a second optical cavity having a second optical axis and second,  
5 different, optical modes than the first optical cavity;  
the first and second optical cavities being at least partially separated from each other by a photonic crystal material such that optical coupling between the first and second cavities is achieved through the photonic crystal material; and  
10 the photonic crystal material being formed in a quantum well intermixed region of the substrate in which the device is formed, the dielectric function of the photonic crystal material exhibiting a periodic variation as a function of linear distance through the material.
- 15 15. The optical device of claim 14 in which the first and second optical axes are coaxial, the photonic crystal material forming a passive optical coupling medium between the first and the second optical cavities.
16. The optical device of claim 14 in which the first and second optical  
20 axes are parallel.
17. The optical device of claim 14 in which the first and second optical axes are non-parallel.
- 25 18. The optical device of claim 14 in which the first and second optical cavities are of different lengths.
19. The optical device of claim 18 in which one of the cavity end mirrors of the first optical cavity is co-planar with a corresponding one of the cavity  
30 end mirrors of the second optical cavity.

20. The optical device of claim 19 in which the photonic crystal material forms the corresponding cavity end mirrors of the first and second optical cavities.

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21. The optical device of claim 18 in which neither of the cavity end mirrors of the first optical cavity is co-planar with either cavity end mirror of the second optical cavity.

10 22. The optical device of claim 14 in which the first and second optical cavities are separated by the photonic crystal material along lateral edges thereof.

15 23. The optical device of claim 14 further including at least a third optical cavity having a third optical axis and supporting third optical modes,  
the third optical cavity being separated from at least one of the first or second optical cavities by the same or further photonic crystal material such that optical coupling between the cavities is achieved through the same or further photonic crystal material.

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24. The optical device of claim 14 in which the photonic crystal material exhibits a periodicity along an axis orthogonal to the first and/or the second optical axis.

25 25. The optical device of claim 14 in which the photonic crystal material exhibits a periodicity along an axis parallel to the first and/or second optical axis.

26. The optical device of claim 14 in which the photonic crystal material  
30 exhibits periodicity along two or more axes.

27. The optical device of any preceding claim in which at least one of the cavities is non-linear.
- 5 28. An optical device substantially as described herein with reference to the accompanying drawings.